

(PDI) for ten of the plans, and by independent dose calculation checks using RadCalc (RadCalc Version 6.2, LifeLine Software Inc, Tyler, USA).

**Results:** The observed differences between the conventional and the IMRT plans were limited. In average the maximum dose was 0.3 percentage points (pp) lower for IMRT than for conventional plans. The ITV coverage was better for the IMRT plans, with an average ITV minimum dose of 95.9 % compared to 94.1% (+1.8 pp). However, the PTV coverage was slightly worse for the IMRT plans, a decrease of 0.4 pp in V95%. The only relevant organs at risk are the lenses, where the maximum dose on average were lowered 0.3 Gray and the mean dose on average was lowered 0.1 Gray. The average HI for the IMRT plans was 4.0 while 5.1 for the conventional plans. The 10 PDI measurements were all accepted with a reference gamma index value of 5% dose agreement within 3 mm distance to agreement, and no further measurements were performed. Independent dose calculation checks were performed for QA. The time spend on treatment planning was approximately 20 minutes for IMRT plans and could easily be up to 3 hours when using the conventional technique.

	Property	Conventional	IMRT	Difference (Conv. - IMRT)
BODY	Maximum dose	106.4 %	106.1 %	-0.3 pp
ITV coverage	Minimum dose	94.1 %	95.9 %	+1.8 pp
PTV coverage	V95%	99.6 %	99.2 %	-0.4 pp
Lenses	Maximum dose	4.0 Gy	3.7 Gy	-0.3 Gy
	Mean dose	2.8 Gy	2.7 Gy	-0.1 Gy
Homogeneity	D5% / D95%	5.1	4.0	-1.1

**Conclusion:** It was possible to significantly reduce the time spend on dose planning by changing the treatment technique from conventional to IMRT for PCI patients while attaining comparable dosimetric quality of the treatment plans. Furthermore, both the treatment time and the time spend on quality assurances are comparable for the two techniques.

#### EP-2076

**Stereotactic body radiation therapy using Tomotherapy for refractory metastatic bone pain: case study**

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**Purpose or Objective:** To illustrate the technique and outcome of stereotactic body radiation therapy (SBRT) using Tomotherapy for refractory bone pain from metastatic disease. Tomotherapy SBRT planning parameters and dosimetric evaluation are outlined.

**Material and Methods:** In 2013, a 70 year old female patient presented with metastatic non-small cell lung carcinoma, following resection of lung primary in 2012. CT and MRI confirmed a lytic lesion on right of sacrum. Patient's sacrum initially treated with 30Gy/10Fx. Pain recurred 2 months post RT and managed by palliative care. 6 months post RT patient returned for consideration of re-treatment. Pain was refractory to everything apart from 15mg of oxycodone every hour. RO discussed the patient and risks of re-irradiation within the multidisciplinary setting. The consensus was to offer the patient SBRT, 24Gy in 3 fractions to the sacrum. Helical Tomotherapy was used to plan and treat patient. The irregular PTV volume was 201.12cm<sup>3</sup>. Dose volume constraints included: colon (0.035cc<18.4Gy, 20cc<14.3Gy), sacral plexus (0.035cc<11Gy, 5cc<7Gy), cauda equina (0.035cc<16Gy, 5cc<14Gy), and skin (0.035cc<26Gy, 10cc<23Gy). No hotspots were to be located over the nerve roots.

**Results:** Tomotherapy planning parameters included field width of 2.5cm, pitch of 0.2 and a modulation factor of 1.5. Beam on time was 400.3 seconds. PTV coverage statistics were D99 = 22.5Gy (93.75%), V95 = 98.57%, VTD = 90.53%, Median = 25.37Gy (105.71%), D1 = 27.8Gy (115.83%). OAR dose included colon 0.035cc = 8.1Gy, 20cc = 6.8Gy; sacral plexus 0.035cc = 27.3Gy, 5cc = 25.3Gy; cauda equina 0.035 = 26.2Gy, 5cc = 21Gy; skin 0.035cc = 15.4Gy, 10cc = 12.3Gy. The conformity index statistics were R100% = 0.97, V105%

outside PTV = 2cc, R50% = 4.21, Dmax > 2cm from PTV = 16.45Gy (68.5%).

One week post SBRT, patient's pain stable and mobility improving. Whole body bone scan 2 months post SBRT showed decreased activity and size of sacral lesion. 4 months post SBRT patient returned with significant left sacral pain with concern of further metastatic disease. PET confirmed no uptake in left sacrum. Pain associated with insufficiency fracture with cause unknown, SBRT or bone metastasis likely contributors. 5 months post SBRT patient improved dramatically, completely ambulant with PET/CT showing no evidence of recurrence/metastatic disease. 13 months post SBRT, patient remains asymptomatic, CT shows no evidence of metastatic disease.

**Conclusion:** This case study illustrates how the use SBRT can result in pain control for patients with refractory metastatic bone pain where there may be no other options available apart from palliative care, even in cases where the treatment volume is relatively large. This data is also informative since the patient shows no definite evidence of metastatic disease. Further studies could lead to improved therapies for the control of metastatic bone pain.

#### EP-2077

**A decision protocol to propose proton versus photon radiotherapy: in silico comparison**

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**Purpose or Objective:** Proton therapy cancer treatment offer potential clinical advantages compared with photon radiation therapy for many cancer sites. However, the treatment cost with proton is much higher than with conventional radiation. The objective of this study is to discuss how to improve a procedure, already described by others worldwide, to provide quantitative clues to select the patient for proton treatment instead of photon.

**Material and Methods:** The respective medical and clinical benefits of proton and photon therapy are assessed by in silico comparison following four successive steps. First, the dosimetric analysis is made using parameters derived from dose volume histogram (DVH) for target volume and organs at risks. Second, the DVHs are exported from TPS to calculate TCP and mostly NTCP radiobiological indexes. In the third step, a statistical comparison is done using non-parametric test to calculate p-value, then bootstrap method is used to estimate the confidence intervals including the lower and upper limit of agreements. Then the correlation between data from proton and photon treatment planning is assessed using Spearman's rank test. Finally, the cost-effectiveness and quality adjusted life years (QALYs) can be used to measure the outcome of the therapy and check if the therapeutic gain of proton therapy worth the increased expenses of it versus photon.

**Results:** The results with in silico data can be taken into account to make a proposal of a decisional procedure. The dosimetric and radiobiological analysis can be used to check the medical benefit with either proton or photon. The statistical tests allow to check if the dosimetric or radiobiological benefits for a specific patient can be included in the confidence interval of agreement of a representative population, the most homogenous possible. A Markov model can be used to simulate the life of patients treated with proton / photon radiation. The virtual evaluation may indicate for which cancer sites proton therapy could be more cost-effective than photon therapy.

**Conclusion:** The introduction of model based clinical trials with the possibility of individual assessment is a coming approach well adapted to the fast improvement of medical technology. The presently rising offer of proton therapy is a good example. The QALY concept based on objective dosimetric and clinical expected / modeled outcome may be a valuable response to this new challenge. However, large

cumulated medical data are needed to reduce steps by steps the uncertainties in the assumptions used in the present models.

#### EP-2078

**PROSPECT: Phase 2 rescanning of seromas in patients to evaluate CTV reduction in breast cancer**

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**Purpose or Objective:** A single centre feasibility study to assess the reduction in sequential boost volume treated by rescanning patients during their final week of whole breast radiotherapy.

**Material and Methods:** Patients requiring a sequential boost treatment who had a tumour bed seroma greater than 1cm on the initial radiotherapy planning (RTP) CT scan were considered for entry into the study.

Thirty patients were sequentially recruited at the planning stage if they met this inclusion criteria. Patients were consented for entry into the trial and a second RTP CT scan (RTP 2) was conducted in their final week of whole breast radiotherapy. RTP 2 scan was used to determine the volume treated for their sequential boost.

Both scans had the CTV outlined by the chief investigator and the CTV volume changes were annotated.

**Results:** 83% of patients had a substantial reduction in CTV (>25%) in RTP 2 compared to RTP 1. The mean CTV reduction overall was 41.9% with a median reduction 42.5%. The mean time between scans was 27 days; median time 29 days. Mean time from start of whole breast radiotherapy treatment to RTP 2 was 14 days.

**Conclusion:** This study shows that rescanning breast patients during the final week of whole breast radiotherapy leads to a significant decrease in treated boost volume in the majority of patients.

#### EP-2079

**IMRT vs. dynamic conformal arc radiation therapy for stereotactic spinal radiotherapy**

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**Purpose or Objective:** Patients with spinal tumors have better outcomes with increased dose prescription. Due to the complex geometry of the treatment site and to the close proximity of the spinal cord, dose escalation is only possible with advanced techniques. This case study aims to determine if intensity-modulated radiation therapy (IMRT) could be a better option than dynamic conformal arc radiation therapy (DCA) for stereotactic spinal treatments.

**Material and Methods:** Six patients previously treated with DCA were re-planned with IMRT. The same patient-specific criteria were followed in the new IMRT plan. Plan quality was compared by analyzing the dose-volume histogram (DVH) for the planning target volume (PTV) and for the spinal cord (SC). The conformity index (CI) and the monitor units (MU) number were also compared.

**Results:** Both techniques provided adequate PTV coverage and SC sparing. Results favored IMRT in most of the analyzed PTV parameters: Dmax, D95, V95 and V100. DCA showed better results in PTV Dmin and D99 and had advantageous lower MU number. SC had superior dose sparing with IMRT plans. The CI was also improved by the IMRT technique.

**Conclusion:** In general, IMRT plans proved to be a better planning solution, although with a significant higher number of MUs. IMRT treatments must be performed with higher accurate imaging guidance systems.

#### EP-2080

**Redefining the possible: planning multiple complex head lesions using non-coplanar VMAT arcs**

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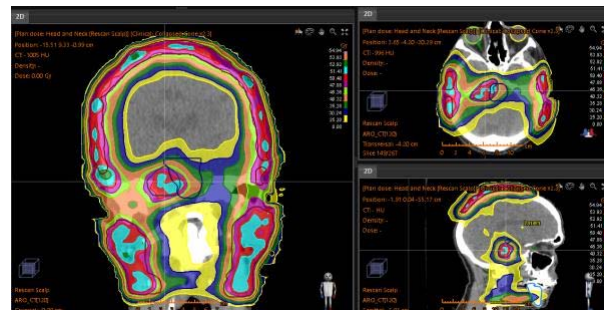
**Purpose or Objective:** To demonstrate the ability to include multiple lesions over the scalp, face and brain using non-coplanar VMAT beams and a single isocentre  
73 yo man referred for post-op RT to multiple scalp lesions, including bilateral spread to periauricular and parotid nodes. Diagnostic work up also showed an incidental right sided meningioma that was indicated for possible concurrent treatment.

**Material and Methods:** The patient was scanned in a Klarity shell, on a Philips Big Bore CT. The dataset was imported into the TPS and diagnostic T1 and T2 MRI's were fused for assisting in contouring.

The scalp and bilateral periauricular and parotid regions were contoured as a single CTV and a 0.3cm PTV margin was added. The meningioma was contoured separately, also with a 0.3cm PTV margin applied.

50.4Gy in 28 fractions was prescribed and the plan was generated in RayStation (v4.0.3) on an Elekta Synergy machine with 4° gantry spacing and a maximum delivery time of 90 seconds per beam. Two full transverse VMAT arcs were used with a partial sagittal arc added (floor at 270°). Isocentre placement was key due to potential collision risks.

**Results:** Exceptional conformality was achieved. The introduction of the sagittal arc created a ring of dose around the skull providing excellent brain sparing as shown in Figure 1.



QA was performed using a 3D diode array with 99.6% pass rate at 3%/3mm criterion (6/1605 failed diodes). Absolute dose measurements were done using a pinpoint ionisation chamber inside both the scalp and meningioma PTVs indicating agreement with the TPS to within  $\pm 3.0\%$ .

XVI imaging was performed on fractions 1 to 3, then weekly, using grey scale match. Bony anatomy matched with  $<1^\circ$  rotation. Treatment delivery averaged at 10 minutes making this beam arrangement extremely efficient to treat.

Treatment was tolerated very well. Some changes to taste, dysphagia and mild to moderate xerostomia developed during the later stages of treatment. This was managed with general analgesia. There was no evidence of recurrence at three month follow up and the RO is now awaiting further diagnostic MRI's.

**Conclusion:** Combining traditional transverse arcs with a partial non-coplanar arc is a safe and efficient technique to treat multiple head and neck volumes and provides exceptional sparing and dosimetric accuracy. The sagittal arc was integral to this conformal distribution over these complex PTV's.